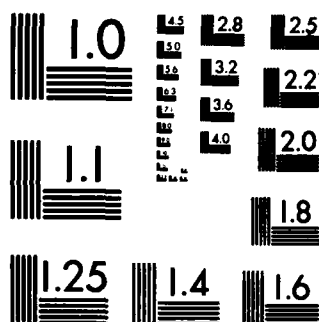END

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CARDIOVASCULAR DISEASE AMONG U.S. NAVY PILOTS

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CARDIOVASCULAR DISEASE AMONG U.S. NAVY PILOTS

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SUMMARY

Problem

U.S. Navy pilots have been reported to be exceptionally healthy, and the only obvious factor detrimental to their health status has been attributed to their hazardous occupation. To protect the health and safety of all pilots, risk factors, if present, need to be identified which are unique to aviation and associated with such serious health conditions as cardiovascular disease (CVD).

Objective

The purpose of this study was 1) to determine the influence of age on CVD incidence among U.S. Navy pilots diagnosed with CVD during a 12.5-year period from July 1967 through December 1979 ($\underline{n}$ = 150), 2) to examine pilots' occupational variables as risk factors of CVD, and 3) to identify precursory diseases reportedly associated with CVD incidence.

Approach

For the first phase, age information from various medical sources was used to determine pilots' age of onset of an acute myocardial infarction, chronic ischemic heart disease, essential benign hypertension, or symptomatic heart disease. Annual incidence rates per 10,000 strength were computed for five age intervals and seven aircraft models for each of the four CVD categories. For the second and third phases, comparisons of mean ages were conducted to determine whether pilots differed from other officers diagnosed with CVD (a total of 316 unrestricted line and 401 Staff Corps officers) on mean age of CVD onset. Means and standard deviations were compared between pilots and a matched sample of 600 controls by CVD category for the six occupational factors (years flown, hours flown as a pilot and copilot, carrier landings, (night, day, and total), and combat hours flown). To identify precursory diseases of CVD for the fourth phase, diagnoses were tabulated for all hospitalizations and board actions that occurred prior to the targeted incident.

Results

Results showed a direct relationship between incidence rates for the four CVD categories and age; for total CVD incidence, a doubling of rates was observed for each successive 6-year age interval beginning with the 36-41 age group. Pilots with chronic ischemic heart disease were more than three years younger on the average than controls at the time of CVD onset. No differences in mean age of onset were observed for acute myocardial infarction. None of the occupational factors was shown to be significantly associated with CVD incidence although fighter pilots had the highest rates of acute myocardial infarction and chronic ischemic heart disease. Angina pectoris was most frequently observed as a precursory disease of chronic ischemic heart disease, and several behaviorally related disorders (e.g., alcoholism) occurred most frequently with hypertension.

Conclusions

Results indicated that if life style or occupational factors had differentiated groups, pilots' mean age at the time of an acute myocardial infarction probably would have differed significantly from other officers, similar to the age differential observed for chronic ischemic heart disease. Because there were no age differences for acute myocardial infarction incidence, the findings suggested that the provision of close medical surveillance might have led to an

earlier detection of chronic ischemic heart disease among pilots than would be the case for other officers. Other findings clearly showed that incidence of an acute myocardial infarction would be difficult to predict on the basis of an individual's previous medical inpatient history. Although the number of hypertensive pilots was small, results of this study provided more support for the influence of life style variables as a risk factor of hypertension than was gleaned from the comparisons of occupational factors.

Recommendations

Because of the small sample of Navy fighter pilots studied in this research, a replication should be conducted on a larger population to determine the extent of CVD incidence associated with high performance aircraft. Also recommended was the implementation of an intervention program designed to modify the life styles of pilots who had been hospitalized for hypertension and/or such behaviorally related disorders as obesity and alcoholism.

Cardiovascular Disease among U.S. Navy Pilots

Cardiovascular disease (CVD) has been reported to be responsible for almost a million deaths annually in the U.S., which represents more deaths than for all other causes combined (1). According to the American Heart Association (1), the major diseases of the cardiovascular system include high blood pressure, atherosclerosis, heart attack (coronary thrombosis, coronary occlusion, or myocardial infarction), stroke, and congestive heart failure. During the past three decades, CVD mortality rates have declined more than 30% in this country. Coronary bypass surgery, the most common type of major surgical procedure in the U.S.—with 170,000 operations performed in 1983—no doubt has contributed to this decrease (21).

Numerous studies, as summarized by Patel (18), have identified the following as risk factors of CVD: cigarette smoking, elevated blood pressure, raised serum cholesterol, Type A behavior pattern, obesity, diabetes mellitus, a sedentary life style, and positive family history. According to Fuchs (9), an elevated blood pressure is the best predictor of subsequent cardiovascular events if data on the other risk factors are unavailable. Age, race, and sex also influence CVD morbidity and mortality rates.

One segment of the U.S. population reported to be exceptionally healthy with relatively low CVD morbidity and mortality rates is the U.S. Navy pilot population. Research conducted over the years, primarily the "1,000 Aviator" project dating from the 1940s, has shown Navy pilots to have a significantly lower mortality rate for CVD than their civilian counterparts or a sample consisting of insured men (8,15). The factor of preselection has been identified as an important correlate of these low rates as well as the characteristics of parental longevity, a higher than average socioeconomic status and educational level, close medical surveillance, physical conditioning, and fitness consciousness (15). The military, moreover, is unique in that it enforces physical fitness requirements for retention, and the majority of pilots assume responsibility for maintaining an acceptable level of fitness (4).

While pilots' CVD morbidity and mortality rates are quite low, several of the aforementioned risk factors have been examined as predictors of CVD among military pilots. MacIntyre and his associates (16), for example, determined that 59% of the pilots in the "1,000 Aviator" study were shown to harbor at least one CVD risk factor, primarily smoking (49%) or asymptomatic hypertension (14%). However, only 6.9% of the total sample developed CVD during an 8-year follow-up period (from a mean age of 52 to 60). Other researchers (3,11) reported age as influencing pilots' CVD morbidity rates in that a large percentage increase in CVD incidence was observed between the ages of the 30s and 40s. CVD also was identified as the second leading specific reason (after hernias) for hospitalization among pilots ages 39 and older (11). With regard to Type A behavior, researchers (5,7) concluded that the characteristics of this behavior constellation were quite common among military officers although this behavior pattern was not correlated with elevation of any common risk factor of coronary artery disease in a sample of senior officers. Perhaps the hostility part, reportedly the most powerful element of the Type A behavior constellation to be associated with the development of CVD, was not a strong component in those officers' behavior patterns.

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In addition to these well-known risk factors, which might have less relevance for the health-conscious pilot population than the civilian community, occupational factors in aviation may be shown to adversely affect the pilot's cardiovascular system. One risk factor that has received considerable research attention was the effect of high sustained G loading on the pilot's health (10,13,19,22-25). The cardiovascular system has been shown to be the most sensitive to high sustained G loading; results of laboratory studies using animals indicated that G loading has the potential of damaging the myocardium (10). Those authors also cautioned that our current knowledge prevented speculation on the long-term health effects of repeated exposure to the high G forces common to high performance fighter aircraft. Research conducted on the health effects associated with aircraft models indicated that older fighter pilots tended to have higher hospitalization rates for CVD than all other pilots (12). Other occupational factors, such as combat experience, carrier lanings, and total flying time, also should be examined as potential risk factors of CVD incidence.

Another research objective has been to determine the role played by CVD in the causation of aircraft mishaps (14,17,20). Little is known, however, about this relationship primarily because there would be insufficient time for tissue change to occur, which at autopsy would make it impossible to implicate a myocardial infarction as the cause of the mishap. Also to be considered as a reason for this lack of association was the fact that most pilots discontinued flying subsequent to being diagnosed with CVD, which was supported by the report showing CVD as the major reason for "grounding" U.S.A.F. and commercial pilots (20). Another explanation was that for those relatively few pilots with CVD, a proportion might have become a CVD casualty after changing from active flight status to an administrative position.

The purpose of this study was 1) to determine the influence of age on CVD incidence among U.S. Navy pilots diagnosed with CVD during a 12.5-year time period from July 1967 through December 1979 ($\underline{n}$ = 150), 2) to examine pilots' occupational variables as risk factors of CVD, and 3) to identify precursory diseases associated with CVD (e.g., essential benign hypertension, diabetes mellitus, and gout)(2,6,9). Results of this longitudinal study can be used as the basis for developing intervention and prevention programs to reduce even further the low incidence of CVD among Navy pilots.

DATA AND METHODS

Study Population

This study included 150 male Caucasian U.S. Navy pilots who had been diagnosed with CVD (i.e., acute myocardial infarction, chronic ischemic heart disease, essential benign hypertension, and symptomatic heart disease) as determined from four medical data files maintained at the Naval Health Research Center in San Diego. This medical information encompassed a 12.5-year period from July 1967 through December 1979 and included three diagnoses for each of six hospitalizations, diagnoses for each of six possible medical boards and one physical evaluation board, and the underlying cause of death. Death data only were available for the 1974-1979 time period. The diagnostic nomenclature used was the International Classification of Diseases Adapted for Use in the United States (ICDA-8). Other data collected were the pilot's age at the time of each medical event as well as the date. (A medical board typically determines whether or not an individual

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should return to full active duty whereas a physical evaluation board ascertains the extent of disability incurred and the amount of disability compensation to be awarded.) Because a pilot could be diagnosed with more than one of the four CVD categories, assignment to each disease classification was accomplished, first, by selecting pilots who had experienced an acute myocardial infarction (n = 31), and, second, by identifying those pilots diagnosed with chronic ischemic heart disease (n = 28), followed by men with essential benign hypertension (n = 44) or symptomatic heart disease (n = 47).

These 150 pilots represented less than 0.7% of all pilots (n = 22,245) included on the Individual Flight Activity Reporting System file during the 12.5 years surveyed for this study. Information extracted from this file, which was provided to the Naval Health Research Center by the Naval Safety Center in Norfolk, Virginia, consisted of first and last year of flight status, total hours flown, types of aircraft models flown, number of carrier landings, and total hours of combat. The 150 pilots were classified according to the aircraft model type they primarily flew: fighter (n = 17), attack (n = 27), electronics (n = 7), helicopter (n = 11), patrol/antisubmarine (n = 51), cargo/transport (n = 13), and trainer/miscellaneous (n = 24). Information on birth year was obtained from the officer career history file maintained at the Naval Health Research Center.

Procedure

For the first phase, age information from the various medical information sources was used to determine pilots' age of CVD onset for each of the four disease categories. Annual incidence rates per 10,000 strength were computed by tabulating the number of pilots classified according to each CVD category and age interval (24-29, 30-35, 36-41, 42-47, and 48-53), multiplying by 10,000, and dividing by the mean number of pilots on active duty for that particular age interval across the 12.5 years surveyed for this study. The same procedure was used to calculate pilots' annual incidence rates for each CVD category by aircraft model. Ninety-five percent confidence limits, based on the Poisson distribution, were computed to establish whether or not there were significant differences in rates across aircraft models.

For the second and third phases, comparisons of mean ages were conducted between pilots and other officers diagnosed with CVD (a total of 316 unrestricted line and 401 Staff Corps officers) to determine whether the 150 pilots differed on mean age of CVD onset. For comparisons of occupational factors, a control sample was selected which consisted of 600 pilots who had not been hospitalized for a circulatory disease but who had the same birth year and primary aircraft model assignment as men diagnosed with CVD. Means and standard deviations were computed by disease category for age of CVD onset for the three officer groups as well as among pilots and their controls for totals of the six occupational factors (years flown, hours flown as a pilot and copilot, carrier landings, night carrier landings, day carrier landings, and combat hours flown). The t test technique was performed to determine the level of statistical significance between groups on mean ages and the six operational factors.

In order to identify precursory diseases of CVD for the fourth phase of this study, diagnoses were tabulated for all hospitalizations and board actions that occurred prior to the targeted CVD

hospitalization, board appearance, or death.   Frequency and percentage distributions of these
diagnoses were compared across the four disease categories.

RESULTS

Incidence of CVD by Age among U.S. Navy Pilots

In examining the incidence rates presented in Table 1, results showed that rates for each of
the four disease categories increased with age. As would be expected, relatively few pilots under
the age of 35 were diagnosed with an acute myocardial infarction or chronic ischemic heart dis-
ease; more pilots aged 35 and younger were diagnosed with essential benign hypertension or
symptomatic heart disease.   The highest rates for the age interval of 48-53 were observed for
acute myocardial infarction and essential benign hypertension.   After combining the four cate-
gories, a more than threefold increase in incidence rates was evidenced beginning at age 36. A
doubling of rates occurred for the two subsequent 6-year age intervals, from 15.2 to 60.2 per
10,000 pilot strength.

TABLE I.   ANNUAL INCIDENCE RATES OF CARDIOVASCULAR DISEASE
BY AGE INTERVAL AMONG U.S. NAVY PILOTS, 1967-79.

| | Diagnostic Category | | | | | | | | |
| | Acute Myocardial Infarction | | Chronic Ischemic Heart Disease | | Essential Benign Hypertension | | Symptomatic Heart Disease | | Total | |
Age in Years	n	Rate per 10,000	n	Rate per 10,000	n	Rate per 10,000	n	Rate per 10,000	n	Rate per 10,000
24 - 29	0	0	1	-	11	1.6	13	1.9	25	3.7
30 - 35	3	0.8	0	0	3	0.8	9	2.5	15	4.2
36 - 41	9	3.3	10	3.7	10	3.7	12	4.4	41	15.2
42 - 47	12	7.4	14	8.6	14	8.6	8	4.9	48	29.7
48 - 53	7	20.1	3	8.6	6	17.2	5	14.3	21	60.2
Total	31	2.1	28	1.9	44	2.9	47	3.1	150	10.0

Mean Age of CVD Onset by Officer Group

In Table 2 are the means and standard deviations of age at the time of CVD onset as well as t
test values between pilots and unrestricted line and Staff Corps officers. Significant differ-
ences in mean ages between pilots and the other officers were observed for the category of chronic
ischemic heart disease (42.8 vs. 46.1 and 48.5). Pilots who were diagnosed as hypertensive also
were significantly younger than their counterparts in the unrestricted line group. Other results
of the t tests revealed no significant differences in mean ages between pilots and others for
acute myocardial infarction and symptomatic heart disease. The mean ages at the time of the first
acute myocardial infarction were within a narrow range from 43.3 to 44.4, while somewhat greater
variability (36.2-39.3) was noted for the category of symptomatic heart disease.

Differences in Operational Factors between Pilots and Controls

Results of comparisons of 95% confidence limits across the seven aircraft models indicated
that CVD incidence rates did not differ significantly among these groups. Fighter pilots,

| | Diagnostic Category | | | | | | | | | | | |
| | Acute Myocardial Infarction | | | Chronic Ischemic Heart Disease | | | Essential Bening Hypertension | | | Symptomatic Heart Disease | | |
Officer Occupation	n	Age M(SD)	t	n	Age M(SD)	t	n	Age M(SD)	t	n	Age M(SD)	t
Pilot	31	43.3 (5.3)		28	42.8 (4.8)		44	38.8 (8.5)		47	36.2 (8.3)	
Unrestricted Line	71	44.0 (5.7)	-0.67	86	46.1 (6.0)	-2.64**	108	42.3 (9.8)	-2.07*	51	39.3 (10.4)	-1.62
Staff Corps	86	44.4 (7.2)	-0.85	119	48.5 (7.9)	-3.66**	133	41.5 (10.5)	-1.54	o3	38.0 (10.6)	-0.96

*p < .05; **p < .01.

however, had the highest incidence rates of acute myocardial infarction and chronic ischemic heart disease; cargo/transport pilots had the highest rate of symptomatic heart disease.

Differences in Operational Factors between Pilots and Controls

Results of comparisons of 95% confidence limits across the seven aircraft models indicated that CVD incidence rates did not differ significantly among these groups. Fighter pilots, however, had the highest incidence rates of acute myocardial infarction and chronic ischemic heart disease; cargo/transport pilots had the highest rate of symptomatic heart disease.

Of the other occupational factors, which are presented in Table 3, mean values for each of the four CVD groups were compared with a matched sample of controls. Results of the comparisons showed that none of the six variables significantly differentiated pilots who had suffered a CVD from their controls. Although nonsignificant, pilots who had suffered an acute myocardial infarction had the highest means of all other seven groups presented in Table 3 for numbers of landings (total carrier, night, and day) while pilots diagnosed with chronic ischemic heart disease had the highest mean total hours flown (X = 4,200). The values presented in Table 3 reflected considerable flying experience for all of the eight groups.

Precursory Diseases of CVD

Of the 31 pilots diagnosed with acute myocardial infarction, 18 men (58.1%) had not been hospitalized prior to the incident under study. Only five pilots (16.1%) had been hospitalized previously for coronary heart disease: chronic ischemic heart disease (2 pilots), alcoholism and chronic ischemic heart disease, angina pectoris and chronic ischemic heart disease, and symptomatic heart disease. The other eight pilots had been hospitalized for reasons seemingly unrelated to coronary heart disease (e.g., pneumonia, disease of the eye, malignant neoplasm of the bladder). There were no cases of essential benign hypertension as a precursor of acute myocardial infarction thereby indicating that being hospitalized for hypertension was not a predictor of this cardiovascular disease among Navy pilots. Hypertension, however, was identified as a secondary or tertiary diagnosis of acute myocardial infarction for two of the pilots.

TABLE III. COMPARISON OF OCCUPATIONAL FACTORS BETWEEN U. S. NAVY PILOTS

WITH CARDIOVASCULAR DISEASE AND CONTROLS, 1967-79.

| | Diagnostic Category | | | | | | | | | |
| | Acute Myocardial Infarction | | Chronic Ischemic Heart Disease | | Essential Benign Hypertension | | Symptomatic Heart Disease | | Total | |
Occupational Factor	Pilots M (SD)	Controls M (SD)	Pilots M (SD)	Controls M (SD)	Pilots M (SD)	Controls M (SD)	Pilots M (SD)	Controls M (SD)	Pilots M (SD)	Controls M (SD)
Total Years Flown	16.8 (5.9)	18.0 (6.6)	17.9 (5.6)	16.7 (7.1)	15.3 (8.1)	14.6 (7.7)	12.8 (7.5)	12.6 (7.5)	15.3 (7.3)	15.1 (7.6)
Total Hours Flown	3513.4 (1282.0)	4002.4 (1670.6)	4200.2 (1358.2)	3776.9 (1938.2)	3308.6 (1738.0)	3274.8 (1834.4)	2744.9 (1542.8)	2833.5 (1666.1)	3341.4 (1590.4)	3380.6 (1823.6)
Total Carrier Landings	374.9 (316.6)	316.5 (336.0)	279.0 (261.0)	267.9 (283.1)	304.0 (888.8)	221.8 (248.6)	252.3 (306.0)	243.2 (265.8)	297.8 (539.8)	256.7 (281.6)
Night Carrier Landings	70.7 (66.5)	63.9 (67.5)	57.8 (67.0)	52.0 (64.2)	47.1 (67.7)	48.9 (58.9)	48.4 (59.4)	53.6 (60.0)	54.4 (64.8)	54.1 (62.2)
Day Carrier Landings	304.2 (275.2)	252.5 (286.6)	221.3 (198.7)	215.9 (231.9)	256.9 (835.2)	172.8 (198.3)	203.9 (261.7)	189.5 (213.8)	243.4 (496.2)	202.6 (231.2)
Total Combat Hours	180.7 (244.7)	199.6 (309.6)	141.8 (198.6)	155.4 (229.0)	136.3 (188.9)	132.8 (203.7)	138.1 (193.3)	143.7 (213.7)	147.1 (203.3)	154.2 (237.4)
Number of Pilots	31	124	28	112	44	176	47	188	150	600

NOTE. All t test values between pilots and controls were nonsignificant.

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Of the 28 pilots diagnosed with chronic ischemic heart disease, 17 (60.7%) had no record of a previous hospitalization or board action; the remaining 11 pilots had been hospitalized prior to the incident that resulted in this diagnosis. The precursory disorders included the following: angina pectoris (3 pilots), essential benign hypertension (2), and symptomatic heart disease (2) as well as one case each of diseases unrelated to CVD (symptoms referable to the respiratory system, symptoms referable to the nervous system, sprains and strains, and displacement of the intervertebral disc). In addition to the three pilots included above, four other pilots had medical records showing angina pectoris as a secondary diagnosis to the primary condition of chronic ischemic heart disease; no other diagnosis was identified as quite so closely associated with this disease.

Eleven of the 44 pilots diagnosed with essential benign hypertension had medical records of only one hospitalization with hypertension as the sole reason for the admission. No specific disease was identified as a precursor of hypertension for those six pilots hospitalized prior to being diagnosed as a hypertensive. Perhaps of greatest importance was the finding that essential benign hypertension appeared on the medical records for 20 of the 44 pilots (45.4%) only as a secondary or tertiary diagnosis. In examining the records of these 20 pilots as well as the remaining seven men for whom hypertension was the primary reason for being hospitalized, several disorders were found to be associated with this disorder: alcoholism (3 pilots), cirrhosis of the liver and other liver diseases (3), and two cases each of obesity, gout, an ʼbetes mellitus. These 12 diagnoses represented the hospitalizations of seven pilots which .early reflected a linkage among these behaviorally induced disorders.

Of the 47 pilots diagnosed with symptomatic heart disease, 37 had nc ʿ ʾus hospitalizations and three of these 37 pilots were identified on the basis of their ath records which listed symptomatic heart disease as the underlying cause of death. The remaining 10 pilots had been hospitalized for various reasons; the diagnoses with the highest frequencies included hernias (3 pilots) and alcoholism (2).

DISCUSSION

While the Navy pilot population does not represent a cross section of all U.S. male Caucasians of comparable ages, this occupational group offers a unique opportunity to study CVD incidence in an exceptionally healthy and relatively homogeneous population. Of the few pilots identified with CVD ($\underline{n}$ = 150 in a population of 22,245), an examination of age, occupational factors, and precursory diseases was conducted to determine the influence of these variables on pilots' CVD incidence.

Similar to findings reported in the civilian community, such as the Framingham Study (6), results of this research showed a direct relationship between incidence rates for the four CVD categories and the risk factor of age. This association was especially apparent for total CVD; the observed rate differences with age reflected quite dramatically the steep rise in incidence with each age interval beginning at age 36. A marked difference in age of onset across CVD categories also was observed, which pointed up the higher probability of developing essential

benign hypertension and symptomatic heart disease prior to the age of 30 than was the case for the other two CVD categories.

Perhaps of greater relevance was the significantly younger age at which pilots, when compared with other officers, developed CVD. For the chronic ischemic heart disease group, pilots on the average were more than three years younger than the other two officer groups at the time of CVD onset. Pilots diagnosed with essential benign hypertension and symptomatic heart disease also were younger than the control groups although only unrestricted line officers were significantly older or approached that level. By way of contrast, no differences in mean age of onset of acute myocardial infarction were observed between pilots and the two control groups. Such results indicated that if life style or occupational factors differentiated groups, pilots' mean age at the time of an acute myocardial infarction probably would have differed significantly from other officers, similar to the age differential observed across groups for chronic ischemic heart disease. Because there were no age differences for acute myocardial infarction incidence, the findings suggested that the provision of close medical surveillance and readily available health care might have led to an earlier detection of chronic ischemic heart disease among pilots than would be the case for the less closely monitored unrestricted line or Staff Corps officer. On the basis of these results, it seemed likely that the medical attention provided for pilots accounted at least in part for their younger mean age of CVD onset than other officers.

In comparing pilots in the CVD group with other pilots matched on birth year and aircraft model experience, moreover, results of the analyses failed to implicate any occupational variable as significantly influencing CVD incidence rates. Only a nonsignificant tendency was noted in that fighter pilots had the highest rates of acute myocardial infarction and chronic ischemic heart disease. Because of the limitations of drawing conclusions based on a small sample of fighter pilots diagnosed with CVD, a larger population of high performance aircraft pilots, including personnel from the other services, should be studied to determine whether the trend identified herein is substantiated. With development of a new generation of high performance aircraft, the pilot has been labeled as the "weak link" in the person-machine system (10) while Voge (19) observed that these models will require the pilot to withstand 10 G for prolonged periods of time. Not only has it become crucial to screen for those individuals who have a low +G_z tolerance but also to provide training to increase the tolerance levels in all pilots who fly high performance aircraft. With those operational considerations in mind and on the basis of the proposed study of all military pilots, the revision of physical standards for high performance aircraft pilot selection and retention might more appropriately be recommended.

In addition to comparisons of age and occupational factors, precursory diseases were examined to determine whether any of these conditions could be considered as potential CVD risk factors. For the acute myocardial infarction group, 83.9% of the pilots had no CVD hospitalization recorded prior to the acute myocardial infarction incident. While a precursory CVD hospitalization represents an extreme example of symptomatology, as contrasted with other indicators such as an abnormal resting electrocardiogram or elevated serum cholesterol, other researchers (6,7) reported that 50% and 70%, respectively, of acute myocardial infarction cases had no previous CVD manifestation. Results of this study clearly indicated that incapacitation or sudden death from an acute

myocardial infarction would be difficult to predict on the basis of an individual's previous medical inpatient history. Being hospitalized for hypertension in particular was not identified as a precursor of an acute myocardial infarction; no pilots were hospitalized for hypertension prior to the acute myocardial infarction.

For the chronic ischemic heart disease group, angina pectoris occurred with greater frequency than any other precursory or secondary disease; the number, however, was very low with only seven pilots observed. No disease was identified as a precursory disorder of symptomatic heart disease.

Other results showed a correspondence between essential benign hypertension and several life style or behaviorally related disorders: alcoholism, cirrhosis of the liver and other liver conditions, obesity, gout, and diabetes mellitus. The interrelationship of hypertension with such diseases seemed to reflect a commonality in organ susceptibility and dysfunction. Similar results were obtained in the Framingham Study which revealed that hypertension was associated with diabetes mellitus and obesity (6) while other research identified gout and carbohydrate intolerance as possible adverse side effects of thiazide agents, a common medication for hypertension (9). Although the number of hypertensive pilots was small, results of this study provided more support for the influence of life style variables as a risk factor of hypertension than was gleaned from the comparisons of occupational factors.

To conclude, age proved to be an important risk factor of CVD in this study while none of the occupational factors differentiated pilots diagnosed with CVD from other pilots. Because of the small Navy fighter pilot sample studied in this research, a replication with a larger population should be conducted to determine the extent of CVD incidence associated with high performance aircraft. Also recommended was the implementation of an intervention program designed to modify the life styles of pilots who had been hospitalized for hypertension and/or such behaviorally related disorders as obesity and alcoholism. An example of such a program has been developed as part of the Navy's recently initiated Health and Physical Readiness Program. Outcomes of these recommendations should pave the way for a better understanding of the risk factors unique to the aviation community and for the increased protection of the health and safety of all U.S. military pilots.

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*
This study's objectives were: 1) to determine the influence of age on cardio-
vascular disease (CVD) incidence among U.S. Navy pilots diagnosed with CVD
during a 12.5-year time period ($\underline{n}$ = 150); 2) to examine pilots' occupational
variables as risk factors of CVD, and (3) to identify precursory diseases asso-
ciated with CVD incidence. Results showed a direct relationship between CVD
incidence and the risk factor of age. Also, pilots on the average were more
than three years younger at the time of CVD onset than other Navy officers.
None of the occupational factors was associated with CVD incidence although

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fighter pilots had the highest rates of acute myocardial infarction and chronic ischemic heart disease. Angina pectoris was most frequently observed as a precursory disease of chronic ischemic heart disease, and several behaviorally related disorders (e.g., alcoholism) occurred most frequently with hypertension. Subsequent research should include all U.S. military pilots to provide a larger population in which to examine the influence on CVD incidence of such occupational factors as high performance aircraft. Also recommended was the implementation of an intervention program designed to modify the life styles of pilots who had been hospitalized for hypertension or such behaviorally related disorders as obesity and alcoholism.

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